DETERMINATION OF THE EFFICIENCY OF IMPLEMENTING BLOCKCHAIN TECHNOLOGY INTO THE LOGISTICS SYSTEMS

Dilmurod Turdiboyevich Azimov[1], Mariana Petrova[2]

Abstract: In a supply chain, buyers and suppliers usually try to supply goods or services based on medium or long-term contracts. When executing a supply contract, two partners are required to mutually agree on cooperation in order to successfully respond to uncertain market situations or a supply chain failure. The outcome of the partnership is assessing and considering renewal upon termination of the contract. A partnership after several contract renewals is often viewed as a strategic partnership. Strategic partnership can become more effective and show further growth. Blockchain, which has recently gained attention in the digital commerce market, has technical characteristics that can be used in cooperation between partners. The company's activity is closely related to the need for cargo transportation. Today, the workflow process of delivery is being complicated by the low speed of the logistics cycle, long flow of documents and the presence of errors in them, and security issues. The objective of the research is to define the improvement of the transport logistics system of an industrial enterprise. To define the efficiency, we need to implement blockchain technology, which will solve existing problems in the field of supply management. In this study, the implementation stages of blockchain technology are considered and profitability is defined for future research.

Since the analysis revealed the interdependence and mutual influence of transport and information support in the processes of transportation, we recommend using the performance indicators of the processes of transport and information logistics.

Using the method of analyzing the types and consequences of potential problems, it was found that the main reason that the management of a chemical enterprise should first of all pay attention to complex with a continuous production cycle, is the timely

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execution of all operations preceding the shipment of finished products by a vehicle from the manufacturer. In second place in terms of importance and degree of influence on the transportation process is the execution of documentation, which directly affects the timing of transportation. Their delay leads to a delay in the departure of transport from the territory of the plant and, as a result, the financial costs of storing finished products in and out of the warehouse increase.

As a result of the study, the logistics system of enterprises is considered to be one of the most complex and well-functioning mechanism. Despite the wide variety of interpretations of the basic concepts, it is concluded that the study will use the interpretation of definitions such as logistics, transport logistics, system, transport and transport logistics system. The orientation of the implementation of blockchain technology to the technological side of logistics reduces risks and significantly increases stability, since it forms its practical orientation.

Keywords: industrial enterprise, blockchain technology, supply chain management, logistics.

JEL: L62, M15, L14, D30.

Introduction

An effective and strategic partnership between a buyer and its suppliers is one of the most important success factors in logistics. Supply chain collaboration involves the exchange of key information obtained from the market and global network operations, followed by rapid collaborative decision-making based on the information. By working together to match supply and demand, two trading partners can increase mutual benefits and reduce risks. Since the beginning of the supply chain, the importance of logistics collaboration has been emphasized in both industry and academia. In particular, information technology (IT) such as web services, barcode and RFID have played a critical role in the success of the logistics collaboration. IT integration has made it possible to receive operational information from the logistics, and then share it with interconnected partners in real time. In addition, recent advances in big data analytics, including IT, have increased the transparency and predictability of the business environment (Dyachenko et al., 2018; Petrova et al, 2018; Petrova et al, 2022). As new ITs are developed, their potential applications in collaboration with the supply chain should be explored.

Recently, electronic money, such as bitcoin, has gained attention due to increased use in online and offline marketplaces, as well as wild fluctuations in the value of money in the electronic money transaction market.

This electronic money is based on blockchain technology (Nakamoto, 2008; Underwood, 2016).

Blockchain technology has the advantages of information transparency, information immutability, and a smart contract to support communication and reliability required for logistics collaboration (Kouhizadeh & Sarkis, 2018). We refine these benefits as follows: First, transparency means that relevant information, including transaction history, is visible and traceable to all participants; such data is automatically updated with the latest authorized changes to the associated blockchain networks. Second, the immutability of information prevents information or data in the blockchain network from being changed, or deleted without the consent of network participants. Finally, the smart contract reflects the efficient and convenient management of contracts between logistics partners. In general, blockchain is considered technology that can improve the efficiency and effectiveness of supply chain partner processes. This study suggests that all three benefits positively influence logistics collaboration processes such as supply chain partnerships, which ultimately influences performance.

In a supply chain, buyers and suppliers usually try to supply goods or services based on medium or long-term contracts. When executing a supply contract, two partners are mutually required to agree on cooperation in order to successfully respond to uncertain market situations or a supply chain failure. The outcome of the partnership is assessing and considering renewal upon termination of the contract. A partnership after several contract renewals is often viewed as a strategic partnership. A strategic partnership could become more effective and show further growth. Blockchain, which has recently gained attention in the digital commerce market, has technical characteristics that can be used in cooperation between partners.

Literature review

Since transport logistics is the companion to modern enterprises, without optimal solutions to transport problems, or the presence of a logistics department and well-trained specialists in the field of customs clearance, significant amount of money for delivering goods to customers may be lost, which in the short term will not allow the organization to achieve tactical goals, and in the future - to fulfill the planned development indicators.

A possible solution to this problem in logistics systems may be the introduction of blockchain technology. A blockchain (English: Block chain or chain of blocks) is a continuous sequential chain of blocks (linked list) that contains information in accordance with certain rules (Azimov, 2021).

When the material arrives from the primary source through the chain of production organizations - transport organizations - intermediary organizations to the final consumer, the cost increases (Ishankhodjayev et al, 2021). More than 70% of the final cost of the product includes the cost of storage, transportation and packaging (Logistics information system)[3].

In all functional areas of logistics, the main task is to control the implemented processes. Monitoring of the logistics process is the orderly and, as far as possible, continuous processing of logistics data to identify deviations or discrepancies between the planned and actual values of logistics indicators, as well as analysis of these deviations to identify the causes of discrepancies. The stages of logistics system management may be the following:

- Determination of planned values of logistics indicators;
- Calculation of actual values of logistics indicators;
- Comparison of actual and planned indicators (identification of deviations);
- Analysis of identified deviations.

Internal control is an audit procedure that is carried out to evaluate the effectiveness of the procurement service; in general, its relations with internal consumers (other services), the working methods used by the staff of the supply service, and relations with suppliers are evaluated. The logistics system has to be constantly developing and become more complex in order to keep high competitiveness. Effectiveness of the logistics system from an economic, operational and technical point of view reflects the performance indicators, needed to be analyzed in order to overcome competitiveness issues. Logistics performance indicators can be direct or indirect, absolute or relative. Direct indicators of logistics activities are more suitable for analyzing the causes of the current situation and finding management decisions. Indirect indicators of logistics performance, such as profitability or payback period, are often related to finances.

The use of indicators usually makes sense only if they are compared with similar indicators of other enterprises or with the same indicators obtained for a different period of time (Lukinskiy et al, 2000).

In modern transport logistics, when choosing the best routes and transport, computer processing of the initial data (orders, cargo parameters, vehicle fleet, etc.) is necessary. This is due to the constantly growing volumes

[3] Access mode: http://www. tadviser.ru/index.php/ (accessed on 14 April 2021)

of data on the state of control objects. Shelter data is sent to the control center from satellites in a “closed” form, processing the workflow of data manually becomes difficult, which leads to a loss in the effectiveness of decision-making and an increase in errors.

A possible solution to this problem in logistics systems could be the blockchain technology, which can contain data based on certain rules and independently processed on different computers (Swan, 2017).

All blocks in the blockchain technology are interconnected, which cannot be changed. Blockchain can overcome the barriers related to security issues in logistics systems. Computer algorithms written in the chain of blocks, called smart contracts, allow you to automate many logistics processes and, therefore, reduce their prices, as well as reduce the influence of the "human factor". By the implementation of blockchain technology in the technological side of logistics systems we can decrease risks and increase stability. The implementation of blockchain technologies in industry is beneficial for increasing efficiency in document management, data storage, supply chain management, payment systems, e-commerce, and voting systems and public opinion research (Dorokhov, 2016).

Blockchain Technology

Blockchain technology, introduced by Haber and Stornetta in 1991, gained popularity in January 2009 with the launch of Bitcoin (a blockchain cryptocurrency application). A blockchain consists of a series of interconnected blocks, each block containing a set of transactions (encoded with a hash function), a time stamp, a hash of the previous block, a block identifier, and an existing consensus mechanism (Saberi, Kouhizadeh & Sarkis, 2018) shown in Figure 1.

These blocks are recorded in a general ledger in accordance with the agreement rules agreed by the network partners. Because of the fixed features, the blocks are difficult to modify or counterfeit by an individual partner. Blockchain technology provides an effective mechanism for achieving consensus on secure and seamless data sharing without compromising data. This creates technology-based confidence among a group of members who have trust issues that are not centralized in an unreliable and decentralized network (Swan, 2015).

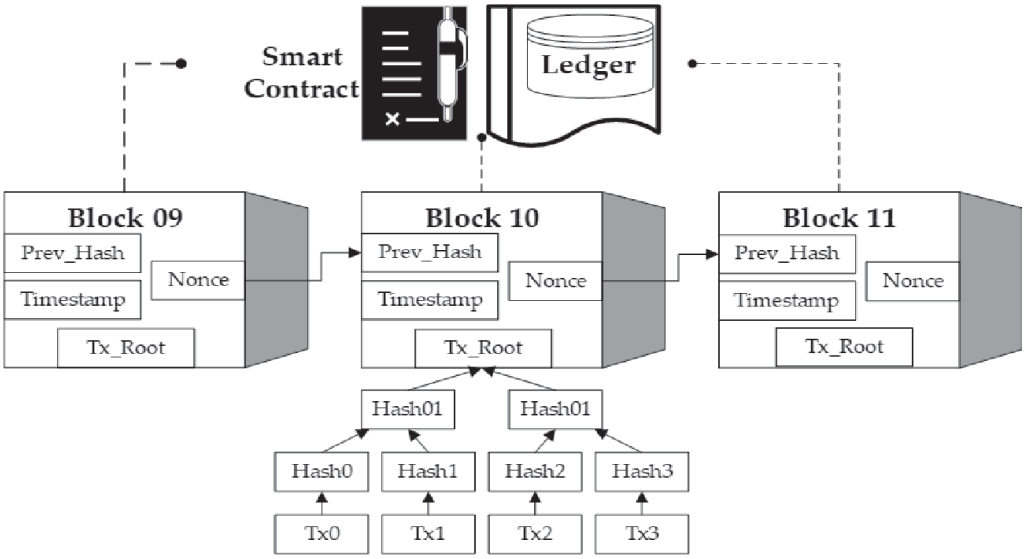

Figure 1. The structure of the blockchain

The most important element of blockchain technology, which ensures network security and keeps the general ledger unchanged, is using the hash function to encrypt each block and connect it to the previous block. This hash function generates a fixed length value (such as 256 bits for SHA-256) for any arbitrary access to a cryptographic function (e.g. Bitcoin, such as SHA-256). There is a fake random output (hash value) for each input value, which is difficult to predict. Two identical entries always create the same unique hash, but a small change significantly changes the value of the outgoing hash. Therefore, any change in the transaction data of a registered block changes the hash of all subsequent blocks (Swan, 2015).

Although blockchain emerged in the last decade, many people still do not fully understand its meaning and therefore cannot even imagine its areas of application.

Blockchain is also often understood to belong to a multi-purpose project type. Because no matter what field you work in, you can do something using blockchain. For example, blockchain can serve as an interesting and promising environment for software developers. For the entrepreneur, the blockchain mechanism can serve as a very convenient tool for reviewing and designing business operations and external relations (Gulyamov et al, 2020).

Entrepreneurs can start startups (new projects) without fear of spending a lot of money on a blockchain, even with a small number of customers. Blockchain is neither a simple object, nor a product, nor a trend, nor a definite opportunity. Perhaps it consists of several parts, some of which work together, while others operate independently and independently of each

other. For the same reason, i.e. due to its modularity, blockchain technology can be applied in many directions and areas.

In general, the development of blockchain technology has a huge innovative potential. Just like the internet economy, blockchain technology is creating a new kind of economy, and that's why we shouldn't overlook the opportunities it offers and have to take advantage of them. A cryptotechnological digital economy will be an economy based on decentralized trust, in political and digital aspect. (Gulyamov et al, 2020)

A blockchain gives everyone the same opportunity, in a sense - equalizing the opportunities of the participants. While the main function of the Internet is primarily to distribute data and ensure its exchange, the function of the blockchain is to transmit data of a certain value. Thus, a blockchain is a promising and future innovative technology. For example, in October 2015, when The Economist published an article entitled "Blockchain, Trust Mechanism," the information quickly spread over the Internet and social media as an innovation around the world.

Because until then, no one had any information about blockchain. Advertising on the front page of a magazine with a great reputation on economics, praising the blockchain, caused a great deal of controversy, of course. According to The Economist, blockchain is a technology that allows confidence, and this trust mechanism, which is based on bitcoin, will radically change the mechanism of operation of the modern economy.

Since October 2015, the information provided by the media on the blockchain chapter has not decreased, but has increased, and a large number of projects based on blockchain technologies, digital currencies and other distributed registers have emerged. Thus, thanks to an article published in a single prestigious journal, many heated discussions on blockchain, bitcoin, cryptocurrency, and distributed consensus began, and a revolutionary march of new technology began around the world.

It should also be understood that blockchain is a digital innovative technology that completely transforms society and the economy, radically changes a number of business models and, as a result, brings confidence as a scientific and technical innovation. Because of the trust, the pressure on the media will be significantly reduced, most businesses and organizations will be provided with blockchain technology, and the number of projects using blockchain will increase, and investors will realize this and focus their efforts on developing such technologies.

As a result, we are also beginning to look at the world in terms of trust because of blockchain technology, and blockchain technology gives us

freedom and confidence. To understand the meaning of this term, we give below its definitions derived from different perspectives and approaches, which allows us to understand it more fully:

A blockchain is a large accounting book or journal (grossbux) on computers running around the world that anyone can add notes to and read at any time.

Blockchain is a software product that allows data to be stored and modified on the Internet in a secure and transparent manner without a central authority.

Blockchain is a digital conveyor that stores various forms of information about transactions, contracts, property documents, works of art, and more.

Blockchain is a technology that provides trust, responsibility, and transparency among all participants through collective agreement and a distributed accounting book or journal algorithm, using a new generation of transactional software.

Blockchain is a database organization technology that relies on the Internet and takes full advantage of all its advantages, including open protocol, encryption, and computing capabilities. This distributed database can be equated with an electronic accounting book in which each transaction is recorded without changing or losing the previous one. This e-book is active, written in chronological order, distributed, verifiable, and protected from falsification of data based on mutual trust (consensus) between system participants (nodes).

Blockchain is a distributed database of transactions that can be compared to a very large and decentralized ‘grossbux’. In it, due to the capabilities of the Internet, data and sizes are transparently protected and stored autonomously. But there is no central body to oversee these processes. The book in which the data is stored is active, chronologically structured, distributed, verifiable, and protected from falsification based on distributed consensus. (Gulyamov et al, 2020)

Each participant of the network has an up-to-date copy of the "grossbook" in a quasi-real environment, and the data contained in it is constantly synchronized between all participants in the network over time. Based on the above, we can conclude that blockchain technology:

- allows us to automate transactions without involving third parties.
- Blockchain is a system based on trust and consensus.
- Blockchain is an infrastructure that provides authentication and notarization.

Examples of the basic principles on which a blockchain system is based are:

❖ There will be a distributed grossbux or 2.0 register organized on the principle of a distributed accounting journal among all participants.

❖ Decentralization and abandonment of intermediaries - the blockchain is not controlled by any centralized body and there is no place for other third parties in the trust system between the two participants.

❖ Consensus: The fact of accepting or rejecting a transaction is the result of a distributed consensus, not a decision of a particular centralized organization.

❖ Invariability and permanence: Records cannot be changed or lost.

❖ Distributed trust and transparency: data, actions and consensus are separated.

In other words, blockchain has the characteristics of working by collective consensus, working with a very large and open accounting journal, decentralization and distribution, ensuring reliability, transparency and generality in the system. It should also be noted that the blockchain is not only a blockchain of bitcoin and etherium systems, and there is not a known single blockchain system.

There are so many non-interconnected blockchains in the world that they can even interact. Thus, technical specifications related to working with some applications in the blockchain may also occur. Blockchain technology creates a distributed algorithmic trust infrastructure, unlike current centralized management. Thus, the blockchain itself includes a distributed algorithmic trust infrastructure or a consensus on demand.

Because of these similar features, most experts compare blockchain to the Internet, and as a result, emphasize the advantage of blockchain over the Internet. The following is a comparison of the two systems:

• The Internet allows you to automate communications (both communication and relationships), while blockchain automates transactions and eliminates third parties.

• The Internet is a decentralized publishing system, and blockchain is a distributed trust system.

• Internet is the publishing infrastructure, and blockchain is the infrastructure for logging in.

Since the period of development of the Internet and blockchain cover the years 1994-2015, the results can be illustrated by the following examples: 1994, Internet:

- interpersonal communication;
- automatic printing;
- electronic commerce;
- social networks.

2015, blockchain:

- decentralization;
- confidence;
- dealing with valuables without intermediaries.

So, there is no contradiction between the Internet and the blockchain, there is only a difference in the development of technology. A registry for creating and using a blockchain (a string of blocks, such as bitcoin) and key encryption for protection, a consensus-based algorithm, and a one-colour P2P (peer-to-peer) network (i.e., a decentralized computer network, in which participants have the same rights) are a necessary element for the operation of the blockchain system. As an example, we take the blockchain of bitcoin and consider the formation of the blockchain, its basic principles and operation. In this case, the blockchain activity is studied in four stages:

Step 1. The agreement between participants is based on the transaction (e.g., money transfer process, assets, financial documents, etc.).

Step 2. The ledger will be scanned by network participants. Based on analysis of the chronology of this journal, network members are assured that the sender actually owns the declared assets.

Step 3. If all work is in place, then the transactions are verified and added to the end of the block chain.

Step 4. The log will be distributed to all network participants. Its scattered state provides protection. It is also necessary to change the logs of network (node) members to falsify any transaction. This, of course, is not possible. To clarify the discussion, we make the following note: “Bitcoin blockchain was first defined as a blockchain. In it, each transaction is encrypted to be one of the blocks. The next transaction, in turn, is encrypted on the basis of the previous block, and so on - the same sequence of actions led to the concept of a blockchain, or in other words, the concept of a blockchain.

Thus, in order to obtain trust status, each agreement (or transaction) must be signed using asymmetric cryptography (public or private key). Thus, three types of information are required to make a transaction in a bitcoin-type blockchain:

- Debit address private key
- The public key to the credit address
- The amount of the transaction

Methodology

Since the analysis has revealed the interdependence and mutual influence of transport and information support in the processes of transportation, we recommend using the performance indicators of the processes of transport and information logistics.

Efficiency of transport logistics processes:

- coefficient of absence of damages ($K_{a.damage}$) is characterized by the ratio of the number of undamaged vehicles to the total number of vehicles;

- coefficient of timely delivery ($K_{t.delivery}$) is characterized by the ratio of the number of vehicles delivered on time to the total number of sent vehicles.

Thus, the integral coefficient of efficiency of transport logistics processes is presented in formula (1):

$$K_t = K_{a.damage} * K_{t.delivery} \quad (1)$$

Efficiency of information logistics processes:

- the ratio of the absence of errors in the transmission of information (Kerror.inf) is characterized by the amount of delivered information to the total amount of transmitted information;

- coefficient of efficiency of information transfer (Kop. inf) is characterized by the ratio of the desired speed of bringing information to the average speed of bringing information.

Thus, the integral coefficient of efficiency of information logistics processes is presented in the formula (2):

$$K_i = K_{error.inf} * K_{op.\ inf} \quad (2)$$

The above coefficients allow us to determine the overall integral indicator of the efficiency of information and transport logistics processes, which is presented in formula (3):

$$E_{overall} = K_i * K_t \quad (3)$$

To calculate the economic efficiency of the introduction of blockchain technology, it is recommended to determine the factors that form the economic damage in an industrial enterprise.

Analysis and results

Transaction costs can be interpreted as costs arising in the process of economic interaction between business entities: “Transaction costs include the costs of making decisions, developing plans and organizing upcoming actions, agreeing on their content and conditions when two or more participants enter into business relations; the costs of changing plans, renegotiating the terms of the transaction and resolving disputes, when dictated by a change in circumstances; the costs of ensuring compliance by

the parties with the agreements reached. The cost of information retrieval arises from the fact that information about potential buyers or sellers of consumer goods or factors of production and current prices is needed before a transaction is made. This type of costs consists of the time and resources required to conduct the search, as well as the losses associated with incomplete and imperfect information.

Transaction costs also include any losses arising from the ineffectiveness of joint decisions, plans, contracts and established structures; inefficient responses to changing conditions; ineffective protection agreements. In a word, they include everything that in one way or another affects the comparative efficiency of various methods of resource allocation and organization of production activities Korchagin, 2016.

Scientists have paid special attention to the accounting and control of transaction costs in railway transport. In their opinion, from the point of view of institutional theory, "the profitability of railway transport assets, which are specific, depends not only on the size of the movement, but also on the level of transaction costs, which depend on the inclusion of ownership relations and the configuration of the organizational structure of the corporation" (Trufanov, 2017).

Often, managers do not take into account the fact of spending a significant amount of labour resources when making management decisions on the withdrawal of various technological functions or business processes. Information security is provided by legal and information services, which also leads to certain costs.

In solving the problems of using intellectual property, not only employees in legal services, but also employees in intellectual property departments are involved, which undoubtedly leads to the diversion of labour resources and, as a result, to additional costs. The formation of tariffs for the provision of services requires a significant diversion of resources, since this procedure is time-consuming.

This area of responsibility also has tenders, tenders and market analysis, which requires the labour of employees in the relevant services. One of the main problems of modern economic analysis is the difficulty of measuring transaction costs. Not all types of transaction costs can be valued in monetary terms. In addition, the usual procedure for expressing the time spent on a transaction in terms of money is imperfect due to the absence, in many cases, of specialized provision of one or another aspect of the transaction (for example, negotiation) by intermediaries.

D. North estimates the level of transaction costs in the US economy up to 40-45%, i.e., up to 4 trillion dollars in year. In practice, when corporations with a complex organizational structure appear, transaction costs become tangible and can reach significant amounts. Thus, to determine the static efficiency of the implementation of blockchain technology, we apply formula (4), (Neshitiy, 2007).

$$E_{impl} = \frac{\Delta D}{C+K} \qquad (4)$$

Where: E_{impl} - indicator of economic efficiency of capital investments;

ΔD - increase in annual income;

C - current annual costs;

K - capital investments.

Based on formula (4), ΔD should be taken in the form of cost savings, prevention and occurrence of logistical risks, as well as an increase in freight turnover.

To determine the dynamic efficiency of investments, the net present value method can be used, which shows the net income or net loss of the investor when putting money into the project and the cash return on implementation. As a cost estimate of the result, cost savings from the prevention or occurrence of logistical risks can be used.

Based on the proposed model for using blockchain technology in an enterprise, we will apply it to an enterprise that is engaged in production.

- assessment of the possibility of introducing blockchain into the enterprise. In this enterprise, the number of employees is 5,097 people, revenue is UZS 59.7 billion per year, net profit is up to UZS 7.1 million per year, the industry is the chemical industry, the average length of the logistics cycle is 10 days, the presence of internal logistics problems - available. Based on the data, we make a decision on the implementation of blockchain technology;

- development of a blockchain system for an enterprise. We will apply an algorithm with a ready-made program core, which allows us to reduce implementation costs by up to 70% and speed up the process of introducing blockchain technologies. Implementation will also require staff training, additional computers, and the purchase of a software product;

- implementation of the blockchain system in an industrial enterprise. At this stage, the system is launched and its effectiveness is evaluated. For evaluation, it is necessary to calculate the efficiency indicators of transport and information logistics before and after the introduction of blockchain technology.

Using the method of analyzing the types and consequences of potential problems, it was found that the main reason that the management of a chemical enterprise should first of all pay attention to is the complex with a continuous production cycle, the timely execution of all operations preceding the shipment of finished products by a vehicle from the manufacturer. In the second place, in terms of importance and degree of influence on the transportation process is the execution of documentation, which directly affects the timing of transportation. Its delay leads to a delay in the departure of transport from the territory of the plant and, as a result, the financial costs of storing finished products in and out of the warehouse increase.

Using the above-mentioned formulas, the total integral an indicator of the efficiency of transport and information logistics processes in the enterprise before the introduction of blockchain technology is:

$$\mathrm{K}_{a.damage} = \frac{10251}{13436} = 0{,}76$$

$$\mathrm{K}_{t.delivery} = \frac{9425}{13436} = 0{,}7$$

$$\mathrm{K}_{a.damage} * \mathrm{K}_{t.delivery} = 0{,}76 * 0{,}7 = 0{,}53$$

$$\mathrm{K}_{error.inf} = \frac{18664}{25459} = 0{,}73$$

$$\mathrm{K}_{op.inf} = \frac{1}{10} = 0{,}1$$

$$\mathrm{K}_i = \mathrm{K}_{error.inf} * \mathrm{K}_{op.inf} = 0{,}73 * 0{,}1 = 0{,}073$$

$$E_{overall} = K_i * K_t = 0{,}53 * 0{,}073 = 0{,}036$$

Conclusion

As a result of the study, the following conclusions have been drawn:

- The logistics system of an enterprise is one of the most complex and well-functioning mechanisms. Enterprises that have switched to organizing the production cycle system in accordance with the principles of logistics can rationally organize production processes.

- The basic concepts related to the system and organization of transport logistics of an industrial enterprise are studied. Despite the wide variety of interpretations of the basic concepts, it is concluded that the study will use the interpretation of definitions such as logistics, transport logistics, system, transport and transport logistics system.

- A comparative description of transportation models is presented, the most progressive model of cargo transportation is demonstrated. The main stages of the transport and technological scheme are also demonstrated.

- The orientation of the implementation of blockchain technology to the technological side of logistics reduces risks and significantly increases stability, since it forms its practical orientation. The introduction of blockchain technology in the industry is beneficial for improving the efficiency of the workflow, data storage, managing the supply of goods, reducing errors in the document flow and its duration, and reducing the duration of the logistics cycle.

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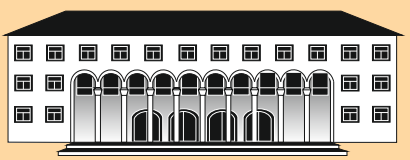

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